CHAPTER 9

SITING OF LOCKS AND DAMS

Section I. Factors Involved

9-1. General. Locks and dams are usually placed within the channel cross section of streams or rivers with or without modification of the channel. In some cases, locks and dams are placed within a cutoff channel or the locks might be in a canal with the dam or spillway located separately in the main channel. Regardless of the layout used, special navigation problems could be encountered that should be anticipated and resolved before the final design is adopted.

9-2. Locks in Stream Channels. Navigation conditions in the approaches to locks placed in a flowing stream will depend largely on the alignment of the channel and channel configuration upstream and downstream. It is important that currents approaching the lock be slow to moderate and reasonably straight within the approach for a considerable distance upstream. Generally, the lock should be sited where downbound tows can complete any change in direction and become properly aligned for the approach before having to reduce speed. Also there should be sufficient sight distance to preclude the danger of collision or interference with other traffic and to permit the tow to maneuver as required for the approach. These requirements indicate the need for locks to be located in reasonably straight reaches. Because of the characteristics of natural streams and other considerations such as foundation conditions, flowage easement, etc., ideal conditions are seldom, if ever, available.

9-3. Other Considerations. The site selected for the lock and dam structure should be one of the most important factors in the development of satisfactory navigation conditions. In addition to other factors, the design engineer should consider existing conditions in the upstream and downstream reaches of the proposed sites (including current directions and velocities), sediment movement for the various flows possible, effects of the structures on the currents and movement of sediment, effects of the resulting currents on the movement of tows, and foundation conditions. The characteristics of the foundation material determined during the early stages of the investigation should provide some indication of the probability that the structures needed can be constructed at reasonable cost with ordinary design standards and could reduce the number of sites considered.

Section II. Channel Alignment

9-4. Effects of Channel Alignment. Locks are usually located along one bank adjacent to one end of the dam. Natural streams having erodible bed and banks will tend to develop a sinuous course consisting of alternate bends and crossings with some relatively straight reaches. The alignment of the channel upstream and downstream of the proposed site will affect visibility and currents that influence the movement of tows approaching the lock. As a general rule, locks and dams should not be located in a bend unless it is a relatively long flat bend.

9-5. Locks on Concave Side of Bends. Locating locks within a bend on the concave side would facilitate the development and maintenance of navigable depths within the lock approaches; however, conditions would be affected by the heavy concentration of flow and high-velocity currents on the lock side of the channel. This condition is aggravated in relatively short-radius bends where the locks have to be placed some distance from the bank to provide adequate sight and approach distance. Usually the best location for navigation in a natural channel is a straight reach downstream of a bend. With locks located on the bank forming a tangent to the concave side of the bend, tows would not have to make a crossing or turn before approaching the lock; thus currents would tend to keep the tow on that side of the river.

9-6. Locks on Convex Side of Bends. Locks located on the convex side of a bend would affect less of the total river flow but would require downbound tows to make a turn for the approach which would place the stern riverward of the bank line in currents moving toward the spillway. Also, there would be a tendency for shoaling on the convex side of the channel. Since many accidents and delays have been experienced by downbound tows attempting to approach locks on the convex side of the bend (such as with Gallipolis Locks and Dam on the Ohio River and Locks and Dam 26 on the Mississippi River), this site should be avoided if at all practical. If such a location cannot be avoided, the locks should be placed far enough downstream to permit downbound tows to negotiate the turn and become aligned for the approach before having to reduce speed and lose rudder control.

9-7. Bypass Canals. Where short-radius bends cannot be avoided, consideration should be given to the construction of the lock or locks and dam in a cutoff channel across the bend. Such location would require considerable excavation but would reduce cofferdam requirements since some of the structures could be constructed in the dry before excavation is completed. With the lock located in a bypass canal and the dam

in the existing channel, careful consideration must be given to entrance and exit conditions at each end of the canal.

9-8. Factors to be Considered. Before the final selection of a site within the existing channel is made, information regarding channel depths and alignment, overbank elevation, and current direction and velocity for all of the navigable flows should be gathered and analyzed with regard to conditions that might result from construction of the structures. Previous studies indicate adequate data are seldom, if ever, available to permit a reasonable analysis of the conditions existing in the reach considered. Time usually will not permit an adequate survey of the reach, particularly since some of the flows that should be considered might not be experienced for several years. In cases where data are limited or the effects of the structures on navigation conditions cannot be fully resolved analytically, use of model studies is highly recommended. These studies would be used to determine the adequacy of the proposed site, the best arrangement and alignment for the structures, and any modifications that might be needed to eliminate undesirable conditions.

Section III. Locks in Canals

9-9. Effects on Navigation. Locks and spillway portions of dams placed in a canal or cutoff channel are subject to the same lock approach conditions as those that would prevail with the structures in a natural channel of the same general alignment. With the lock in a canal bypassing the spillway and dam, navigation conditions could be affected by currents across the upper and lower entrances to the canal, by flow across the canal toward and away from the spillway during higher flows, and by flows caused by lock filling and emptying, depending on the location of the intake ports and emptying outlet. Conditions at the upper entrance to the canal can be extremely hazardous, particularly for downbound tows, because of currents moving across the entrance toward the spillway. When the head of a downbound tow enters slack water, the currents tend to rotate the stern of the tow downstream. If the tow is reducing speed because of a narrow entrance or presence of other traffic, it is in danger of hitting the river-side bank or is in a position to hit the opposite bank.

9-10. Upper Canal Entrance. Flaring of the canal bank on the river side to increase the size of the opening would increase the flow moving across the entrance, producing undesirable conditions for downbound tows entering the canal. It is better to maintain a straight bank along the spillway or river side of the entrance and flare the land side as far as conditions will permit.

9-11. Two-Way Traffic. For two-way traffic, downbound tows should enter the canal from along the land side and upbound tows pass on the river side. With the upper entrance to the canal just downstream of a bend on the concave side, velocities on the canal side will tend to be high, increasing the intensity of the currents moving across the entrance to the canal.

9-12. Flow Across Adjacent Overbanks. Land between the canal and stream should be high enough to prevent any appreciable flow across or from the canal toward the spillway channel during all navigable flows; if it is not, a fill or dike should be placed along the stream side of the canal. When a dike or fill is placed on the river side of the canal, flow from the overbank on the land side of the canal could also increase the flow across the entrance to the canal. If such is the case, flow along the overbank should be diverted riverward by a dike along the overbank some distance upstream of the entrance.

9-13. Lock Filling. Filling the lock from the canal could produce surges varying from a few tenths of a foot to several feet in water-surface elevation peak-to-trough which could adversely affect navigation and operation of the lock. The magnitude of the surge would depend on the length, width, and depth of the canal and the rate and frequency of lock filling. Surges could cause barges to hit the bottom of the canal during the trough of the surge wave if adequate depths are not provided to compensate for its effects. Currents varying in intensity and direction which cannot always be anticipated by the pilot would also develop within the canal. The change in the water-surface elevation caused by the surge would also affect the head on the upper lock gate and could cause delays in opening of the gate. Surges in a canal can continue for several hours and if successive lock fillings occur, the magnitude of the surge can be several times greater than that for a single lock filling. Filling of the lock from the river side of the canal would eliminate the tendency for surges; however, a difference could result between the water levels inside the lock and in the canal at the end of the lock-filling operation that might require a special auxiliary filling system or a special gate-opening mechanism.

9-14. Reduction of Surges in Canal. The magnitude of surge in a canal can be reduced by reducing the length of the canal approaching the lock; increasing the cross-sectional area of the canal, particularly depth; using a surge basin near the lock-filling intake; and permitting some riverflow through the canal by providing a ported guard wall on the lock with outlet discharging into the river channel upstream of the spillway. With ports in the guard wall on the river side of the lock, there would be some flow into the canal that would reduce the intensity

of the crosscurrents near the canal entrance and facilitate the entrance of downbound tows into the canal. Flow through the ports in the upper guard wall would also produce currents that would assist tows in moving toward the wall and becoming aligned for entrance into the lock. The tops of these ports would have to be below the depth of the bottom of loaded barges to prevent the tow from being held against the wall.

9-15. Lower Canal Entrance. Conditions at the lower entrance to the canal can also be affected by currents moving across the entrance and lock approach and by surges created by lock-emptying when the emptying outlet is in the canal. Navigation conditions in the lower reach of the canal (downstream of the lock) would depend on the location of the entrance to the canal relative to currents in the main channel. The entrance to the canal should be aligned as nearly parallel to the alignment of the currents as conditions will permit and flared on its landward side. Flow across the canal should be prevented by high ground or a dike installed along its river side. In streams carrying sediment, shoaling in the lower entrance to the canal could be a serious problem and should be considered in the design of the project.